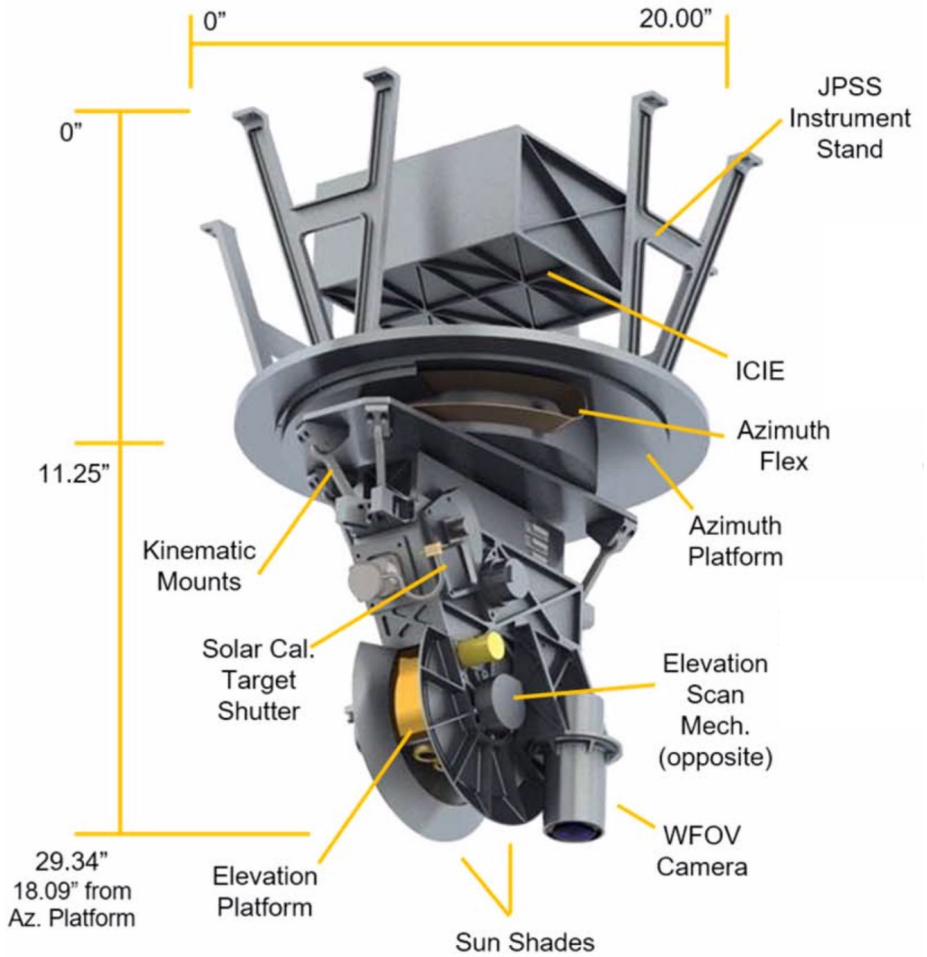
Motivation, characteristics, and use of the Libera wide field of view camera



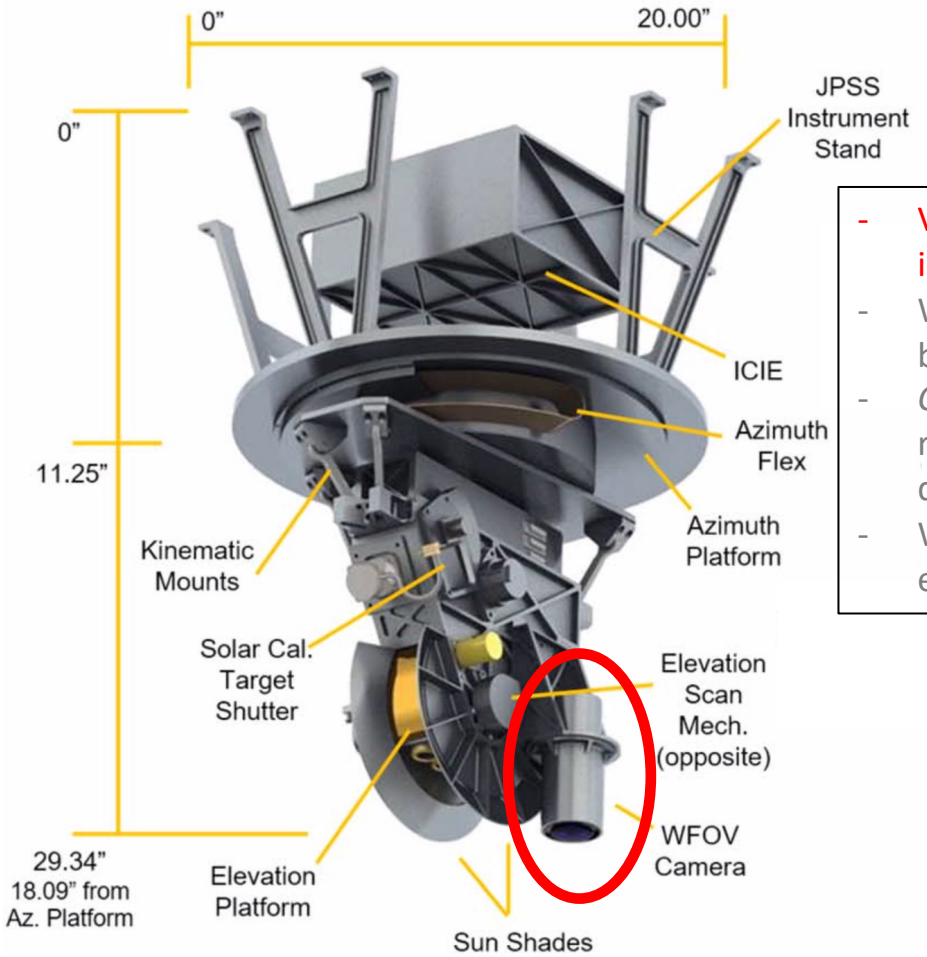
Libera

Understanding Earth's Energy Budget

LASP • JPL • LBL • UA • CSU • UM • NIST • NOAA • Ball • SDL

Sebastian Schmidt and the LASP/Ball camera working group

Motivation



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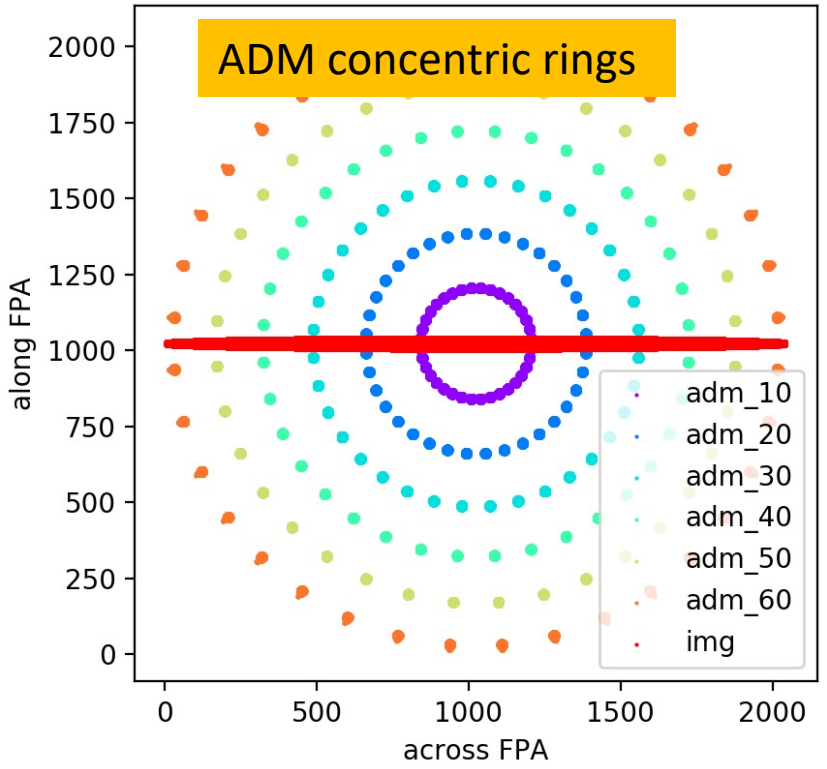

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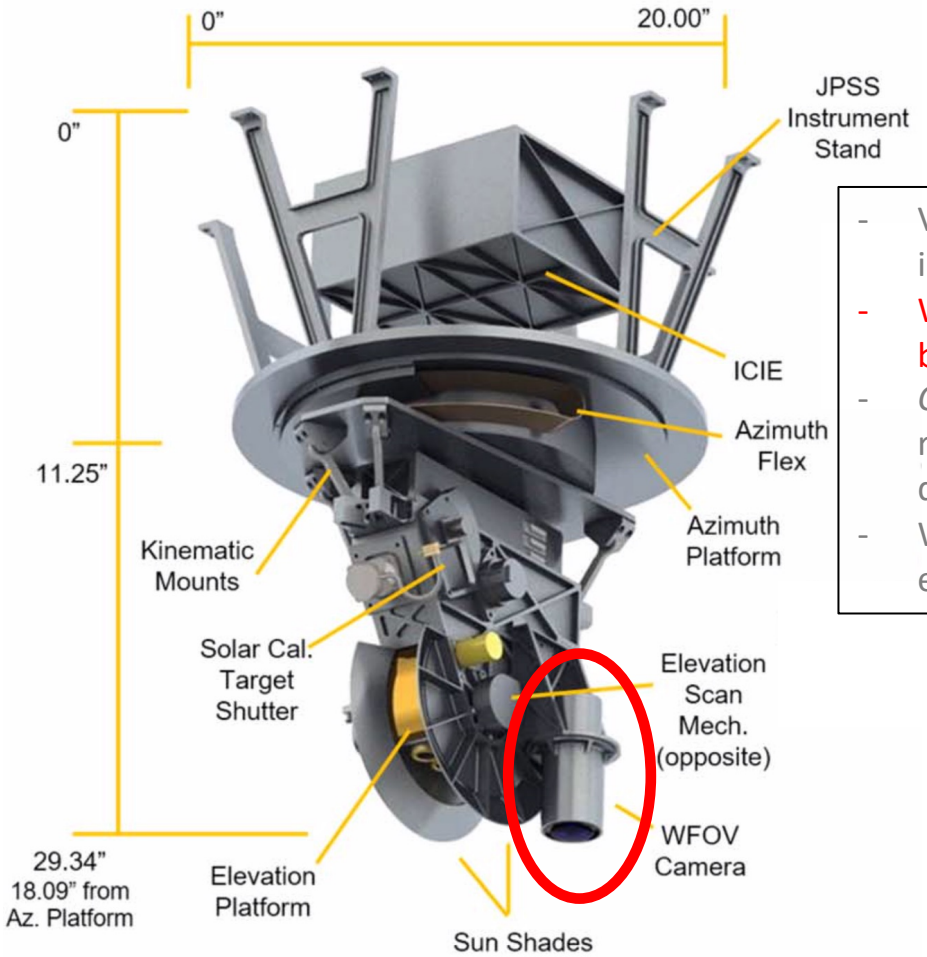

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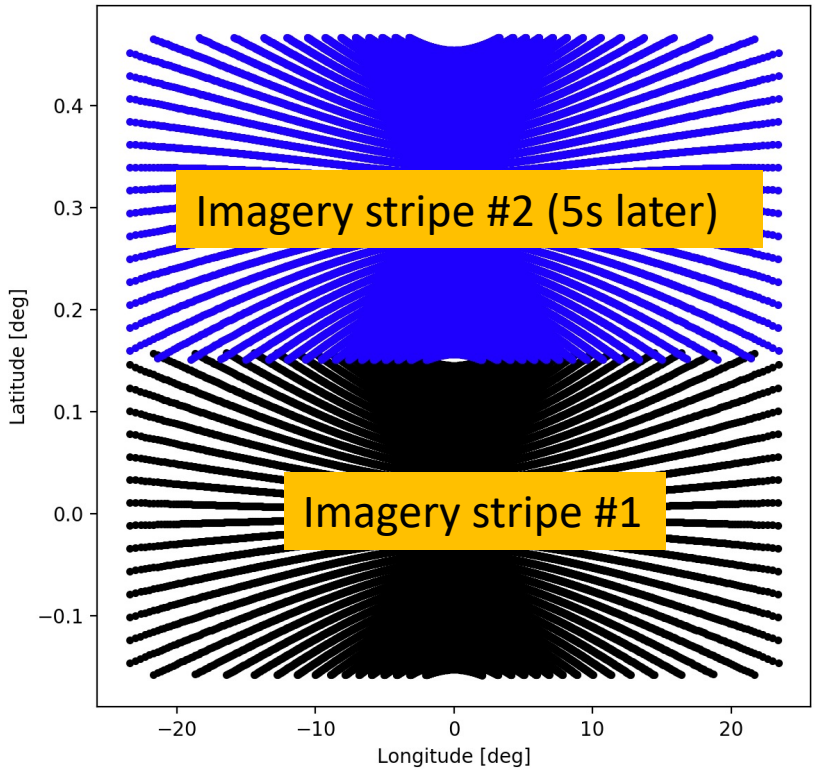

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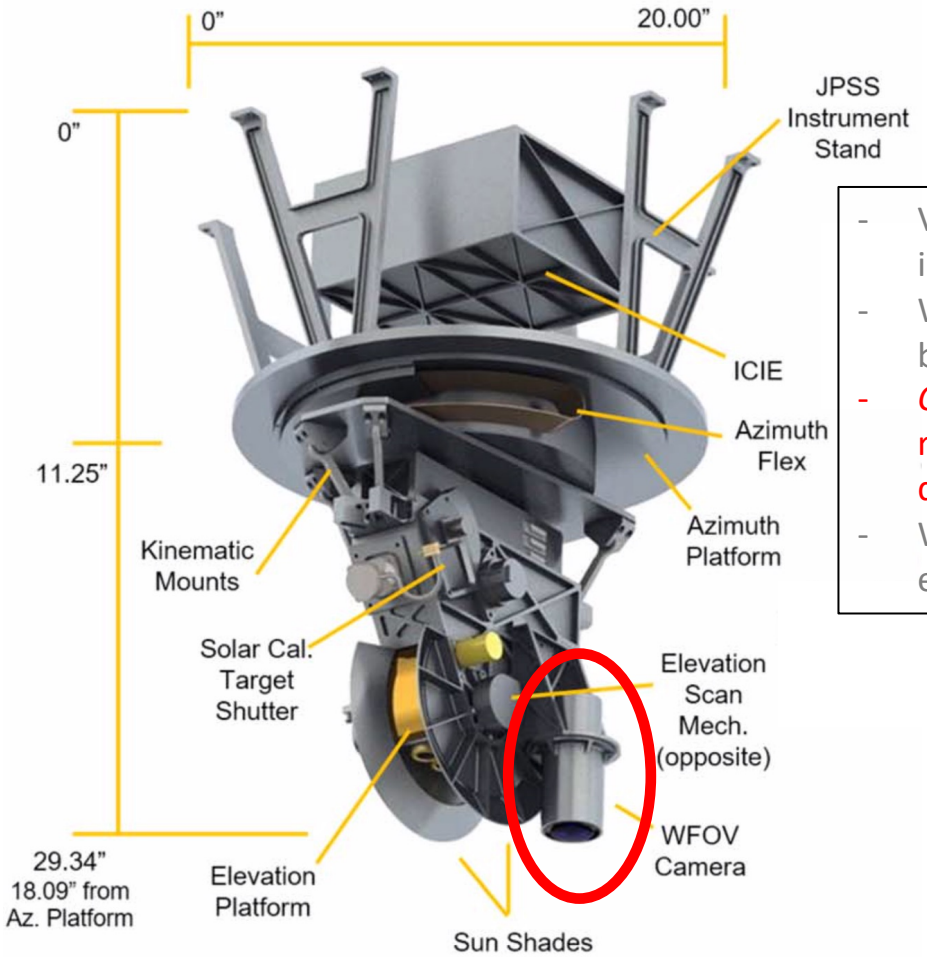

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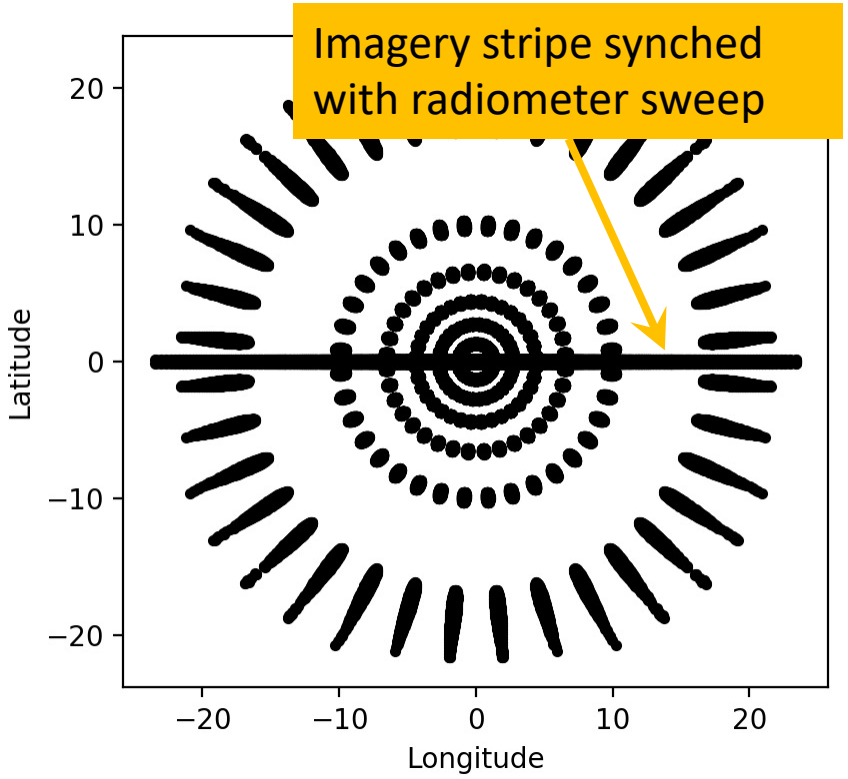

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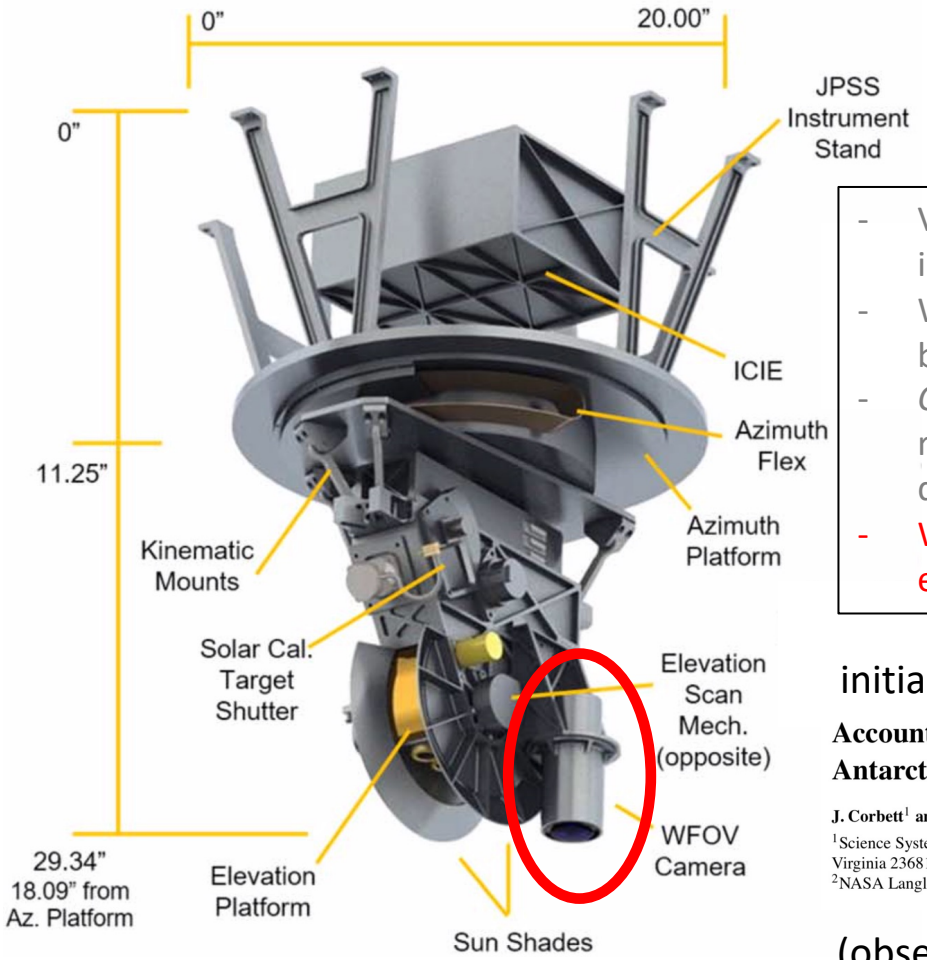

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initial motivation:

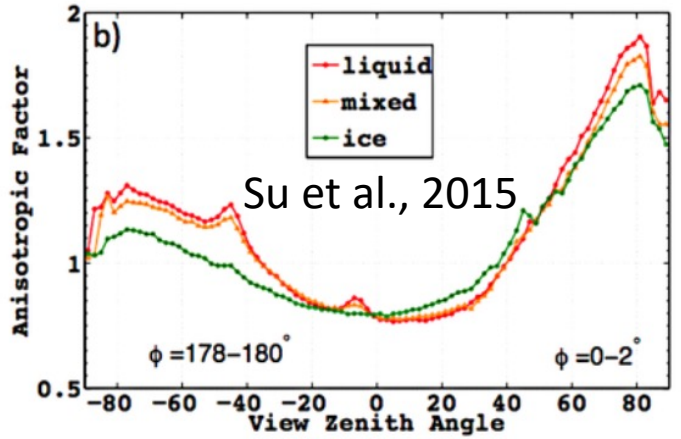
Accounting for the effects of sastrugi in the CERES clear-sky Antarctic shortwave angular distribution models

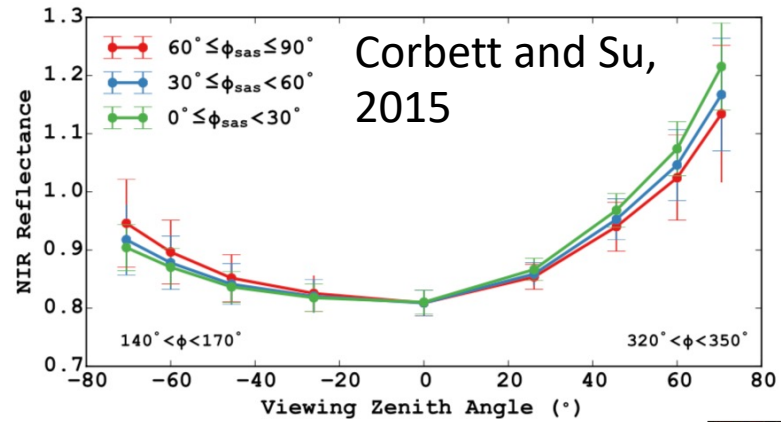
J. Corbett[1] and W. Su[2]

[1]Science Systems and Applications, Inc., NASA Langley Research Center, Mail Stop 420, Hampton, Virginia 23681-2199, USA

[2]NASA Langley Research Center, Mail Stop 420, Hampton, Virginia 23681-2199, USA

(observational instead of RT approach)





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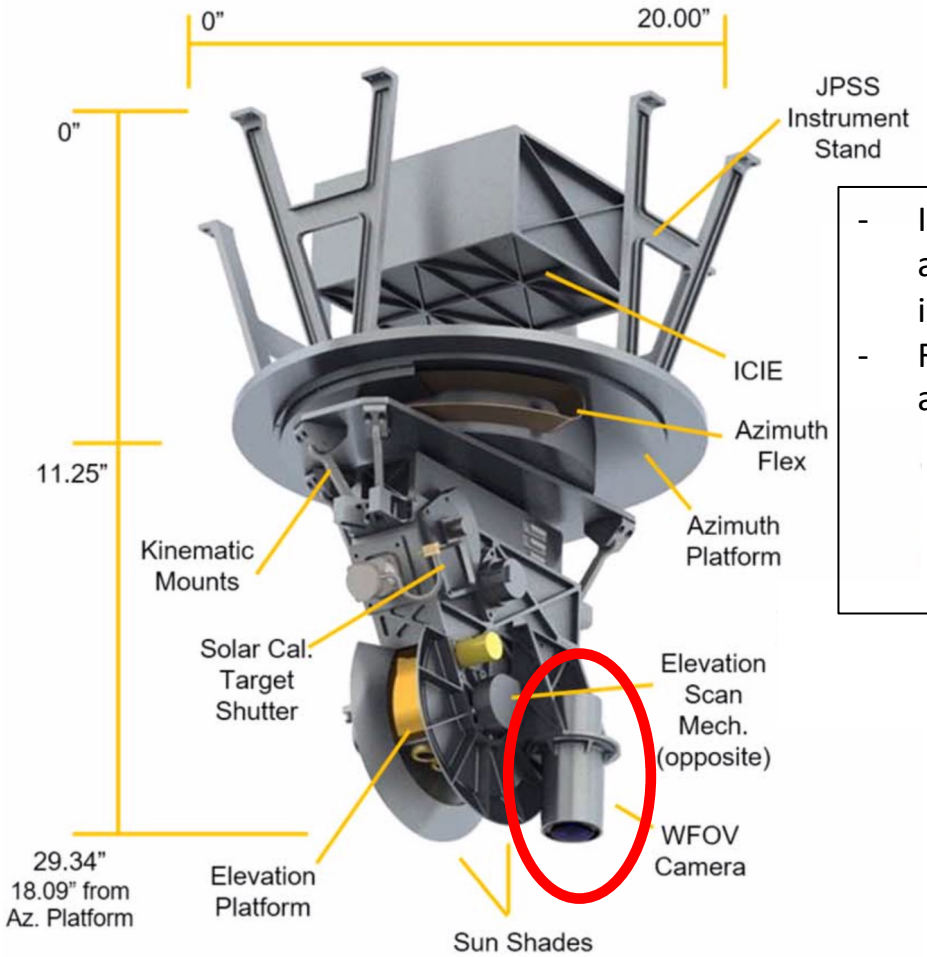

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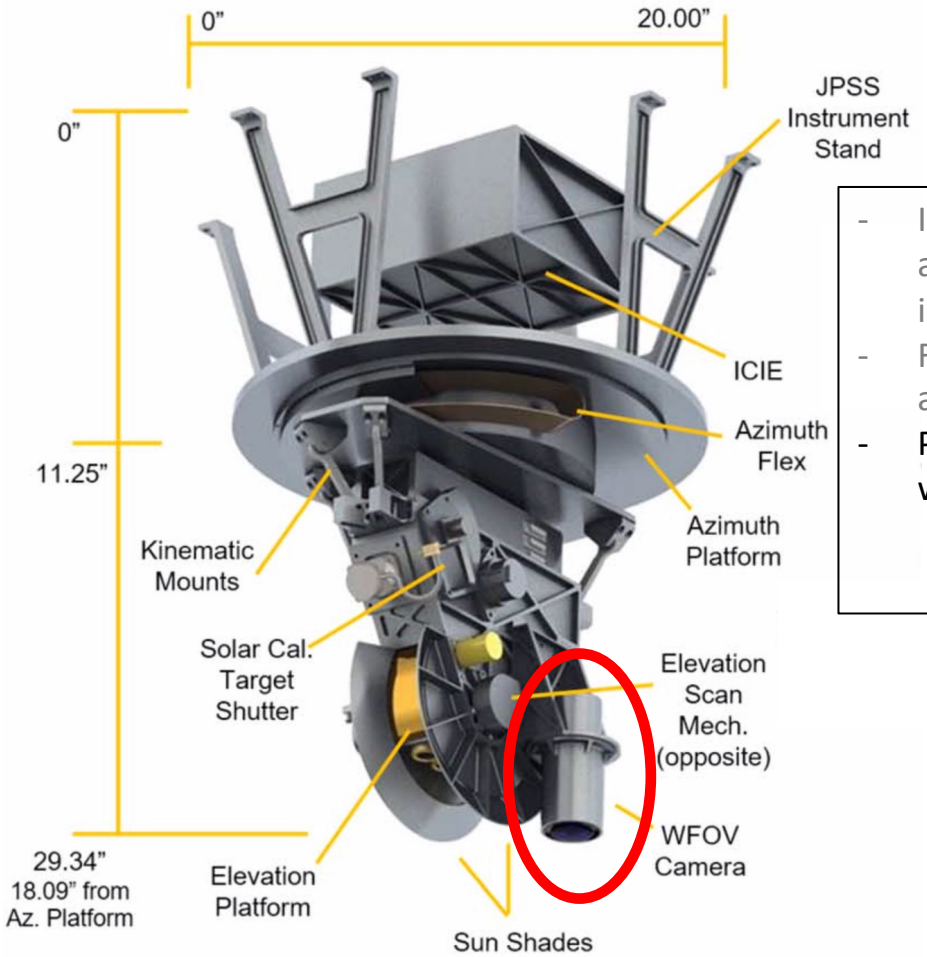

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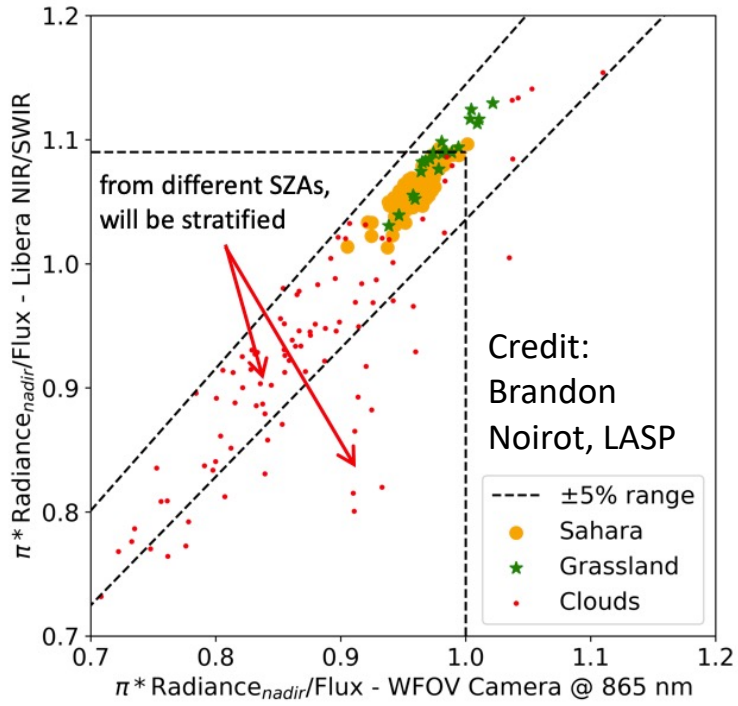

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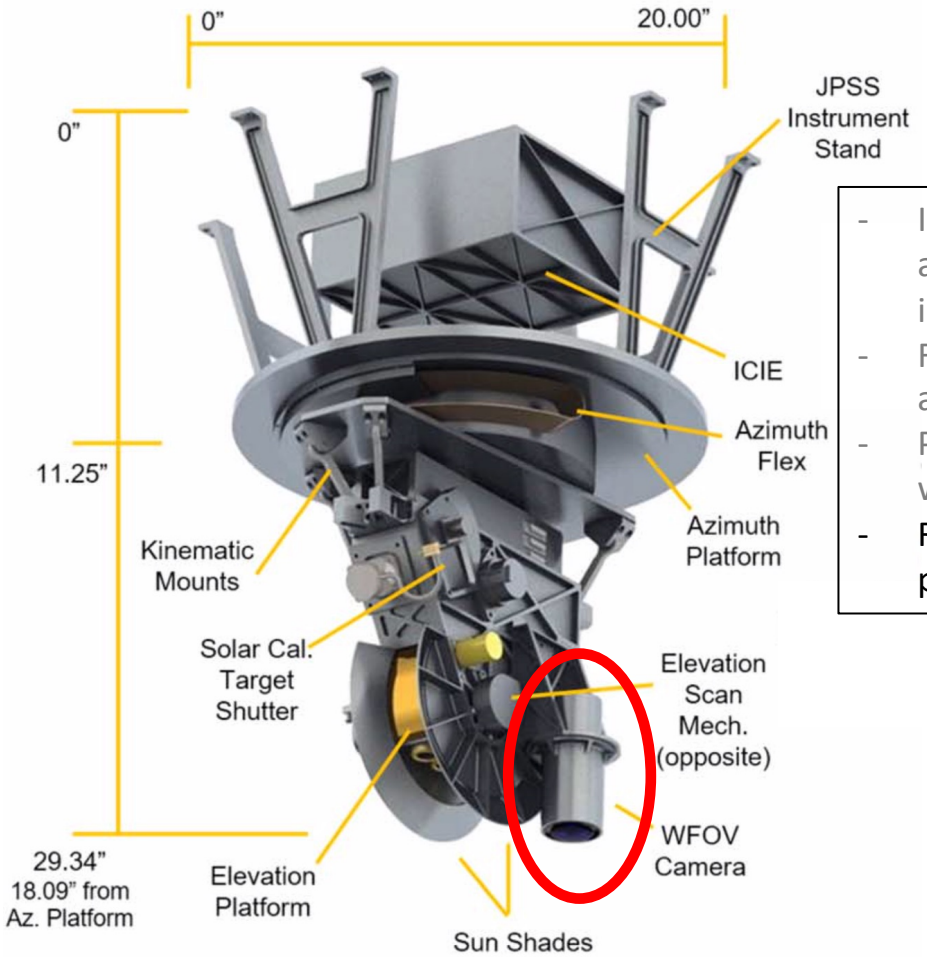

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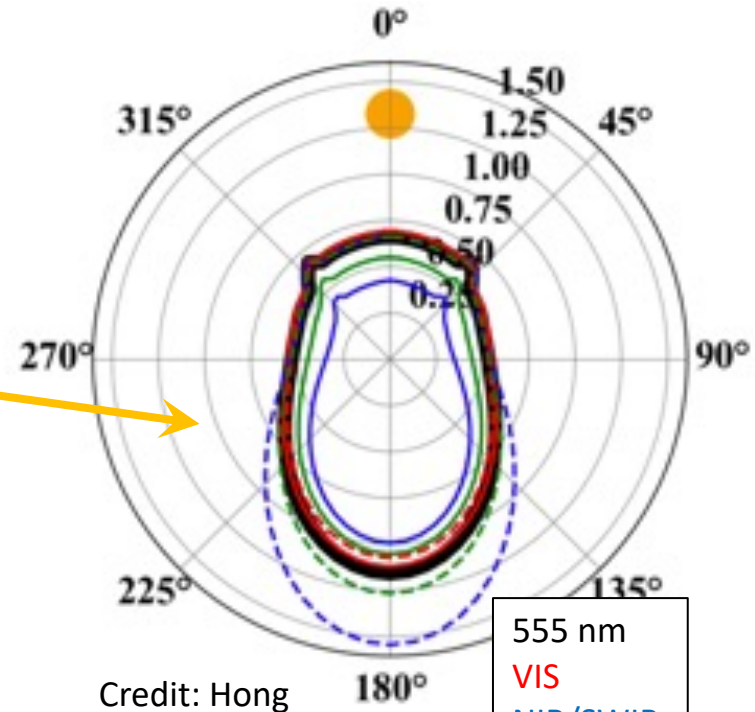
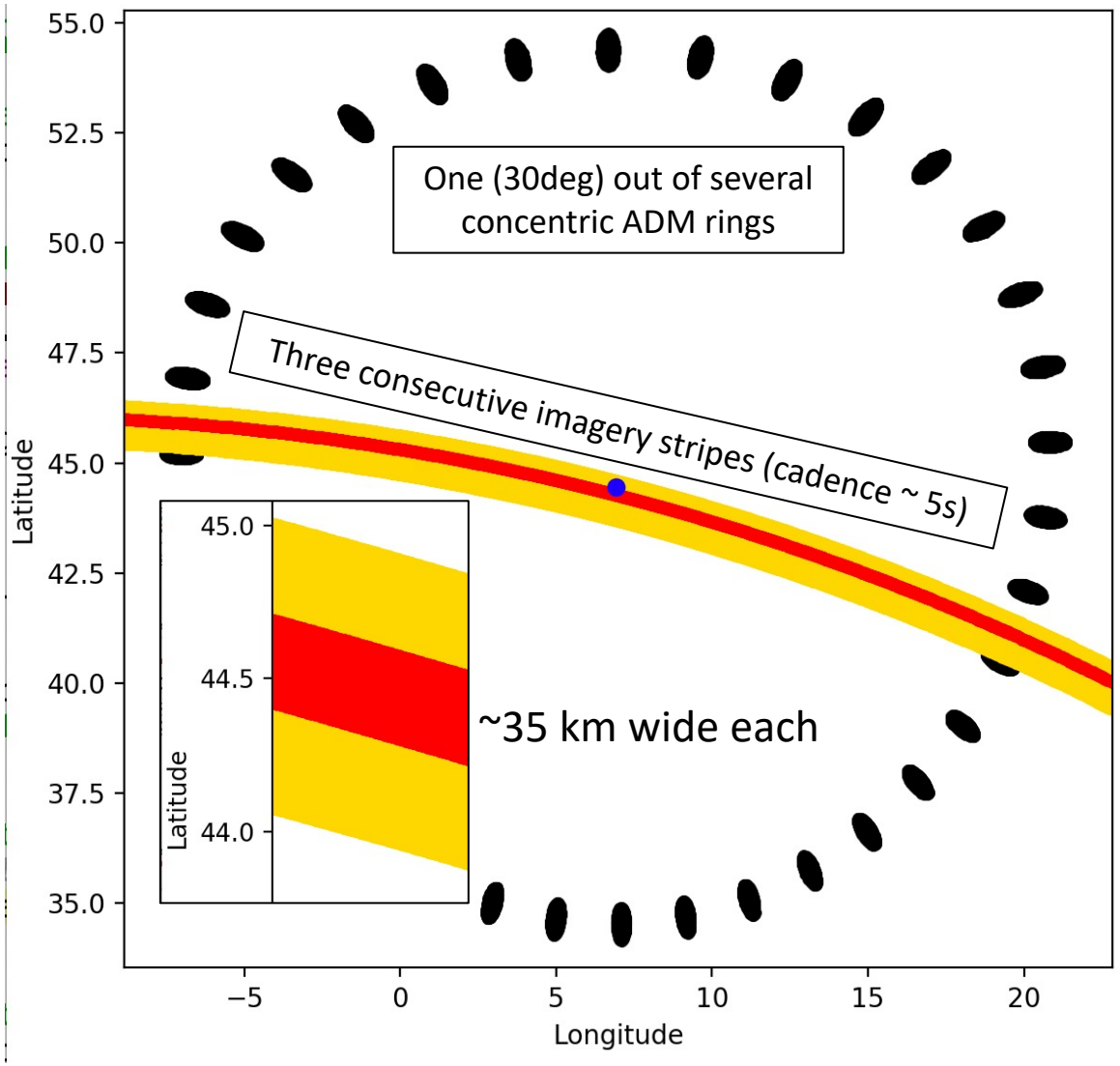
- Radiance at 555 nm serves as angular proxy for VIS band (RT calculations)



Credit: Hong Chen, LASP

General Concept



- 2048 x 2048 pixel hemispheric camera
- 555 nm radiances (VIIRS M4: 0.545 - 0.565 micron)
- 2 overlapping dynamic range settings from 2 integration times for optimal SNR depending on pixel-level radiances

- Sub-sample central imagery stripe + ADM rings at 5 s cadence (we are data-rate limited)
- Solar shroud at ~62deg (limb) to limit degradation of optics

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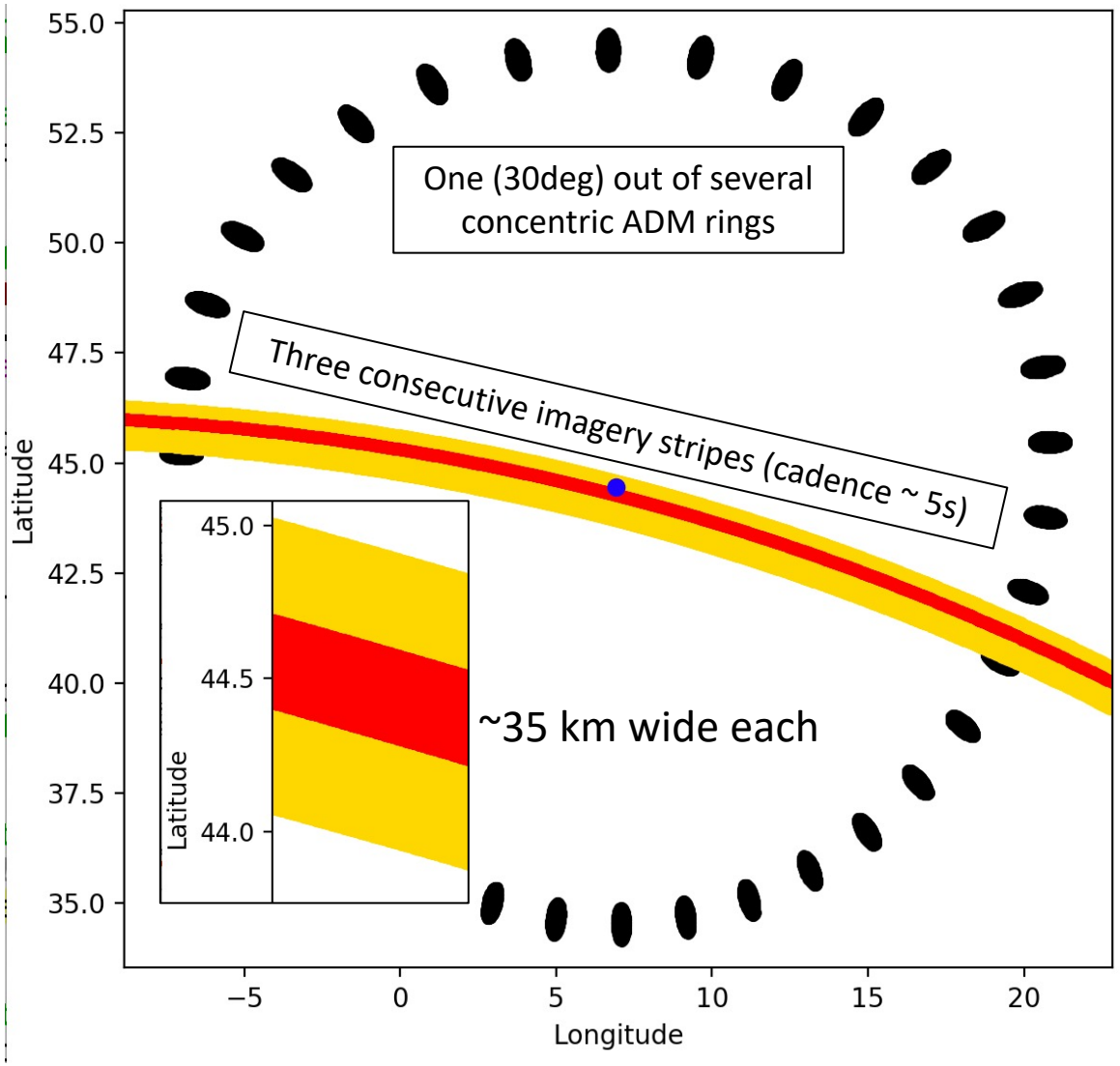

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<u>Products:</u>

- Cloud fraction based on adaptive radiance thresholding @ Libera PSF
- Pixel-level radiances from imagery stripe + ADM
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  - across-track: at Libera radiometer footprints
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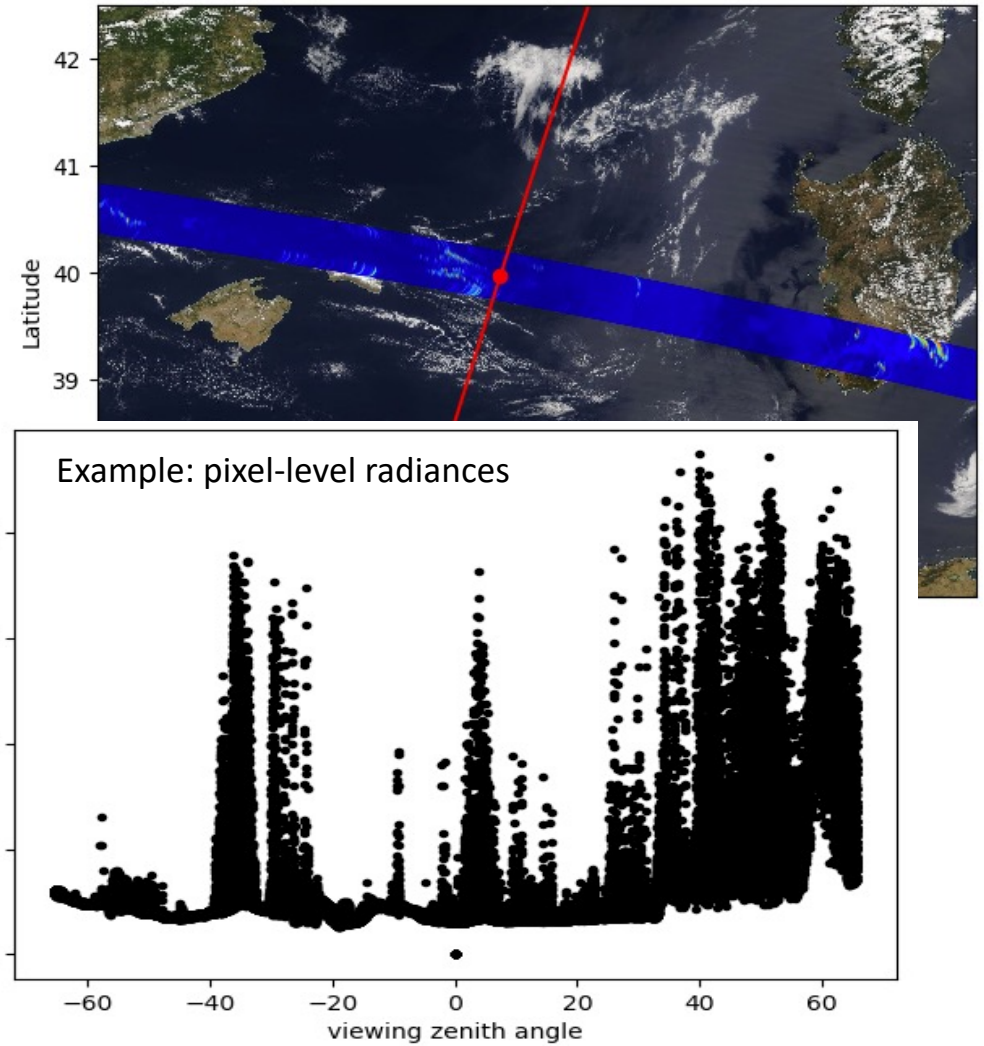

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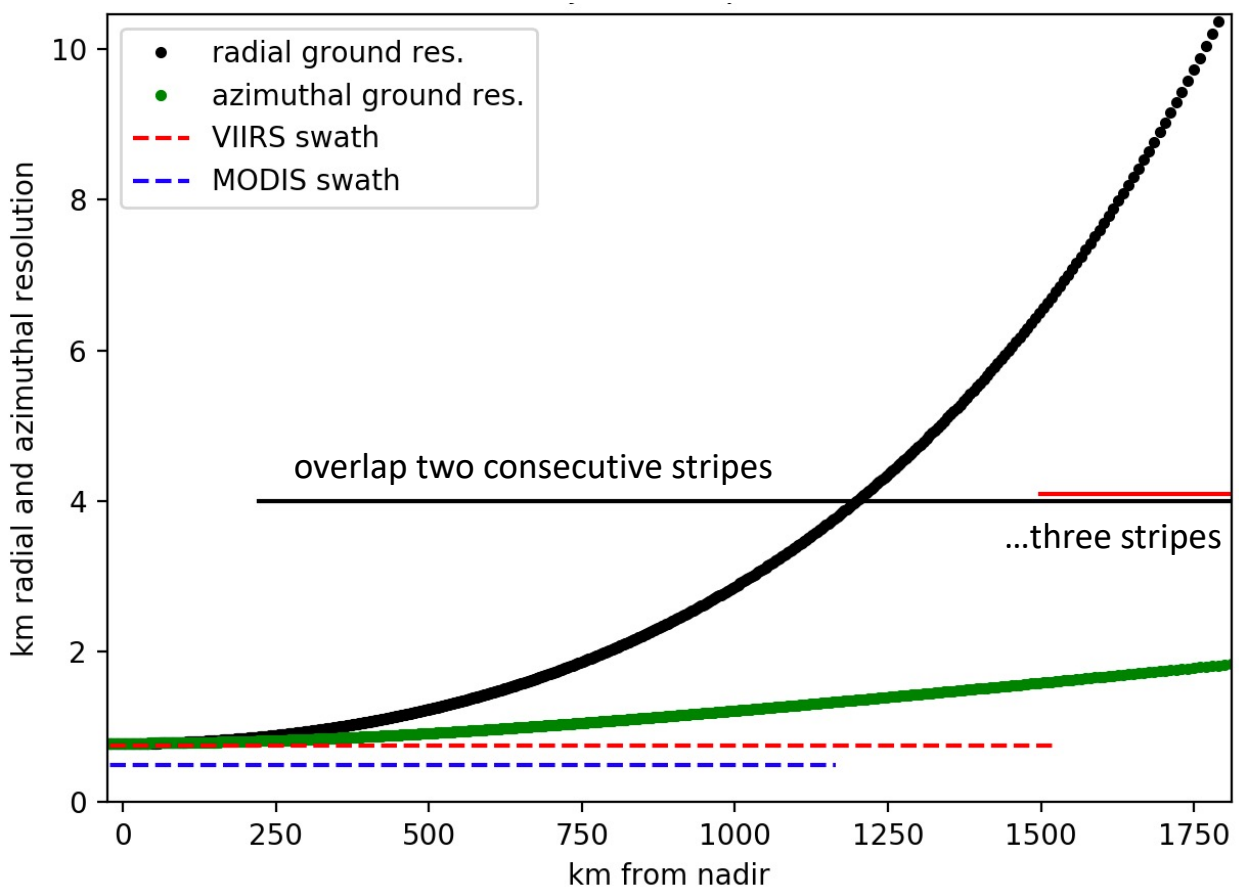

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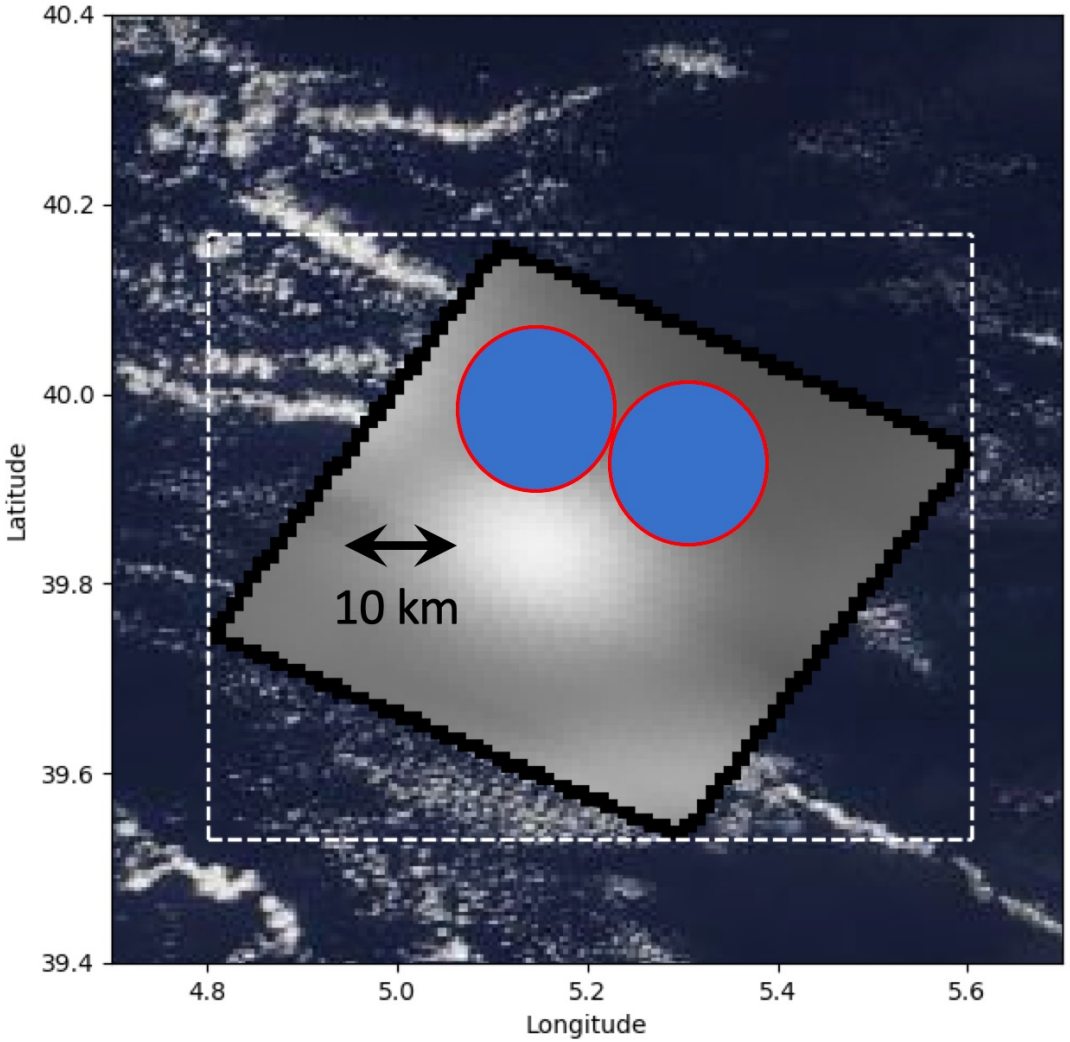

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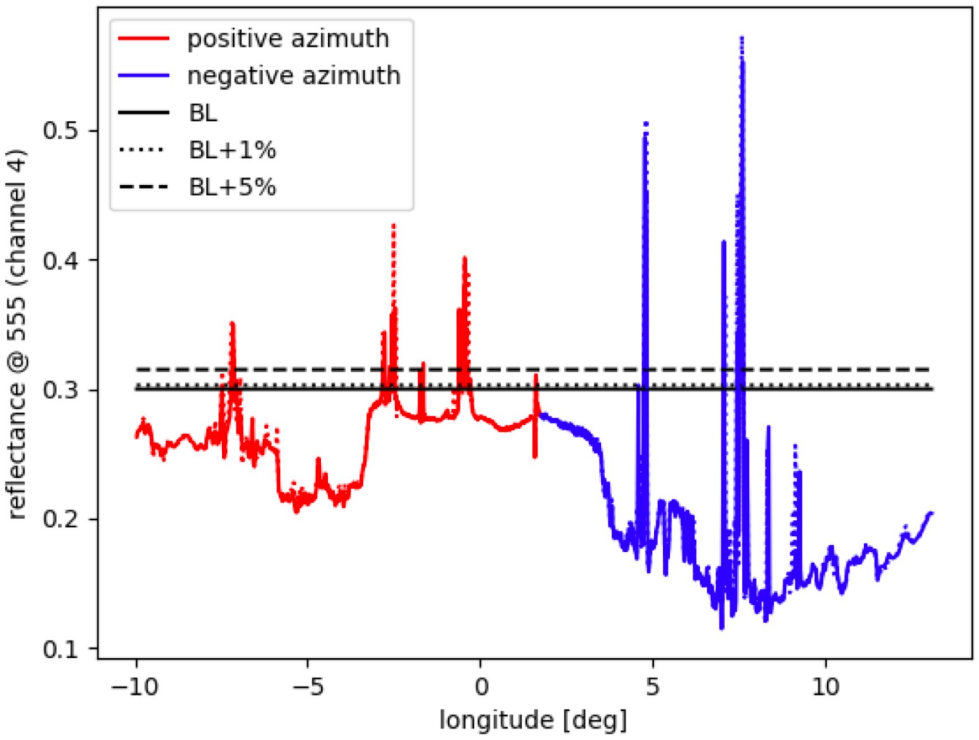
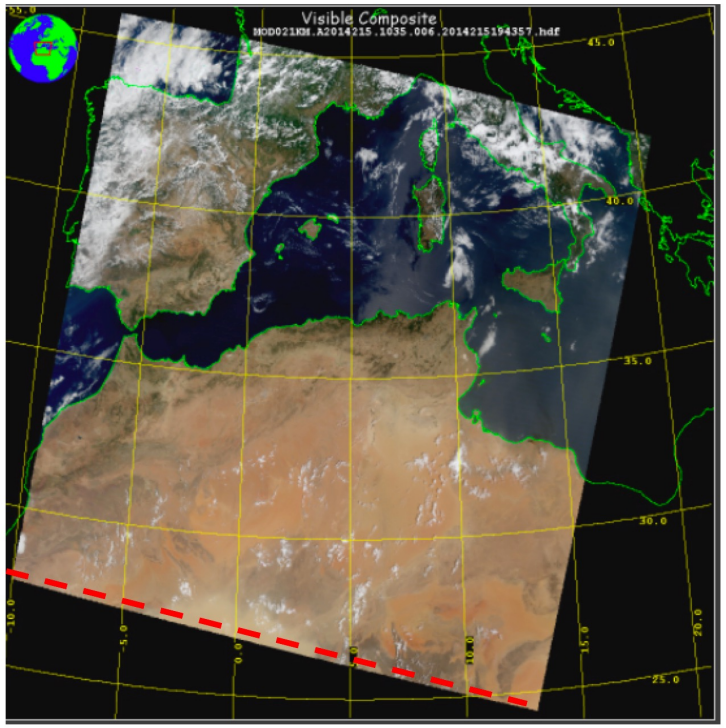
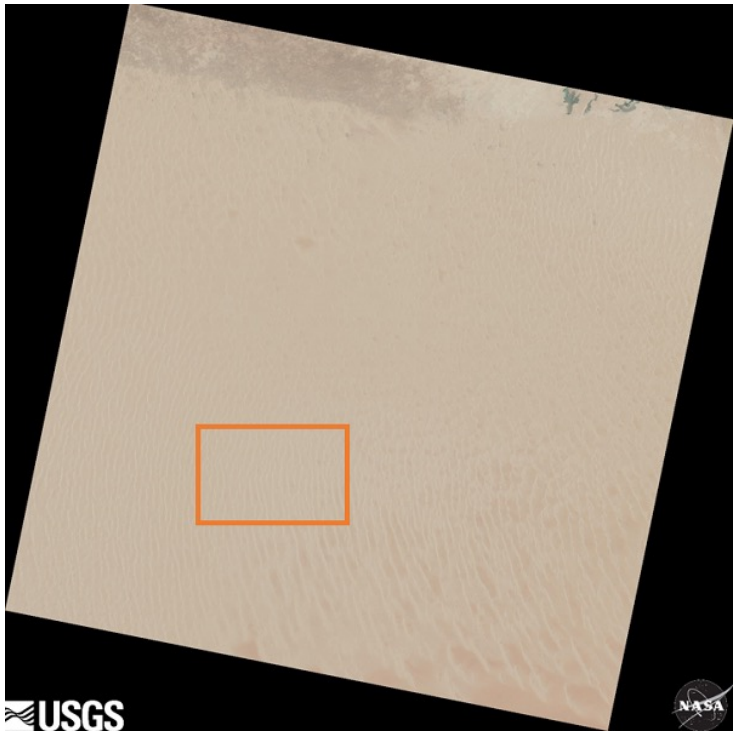
Validation/Calibration

Cross-track: Routine regression of **Libera radiances** vs. **camera radiances** vs. **VIIRS radiances** for numerous scene types
→ check if 555 nm channel does provide proxy measurement for Libera split-solar channel angular radiance distribution
→ Enables vicarious calibration at pseudo-invariant calibration sites





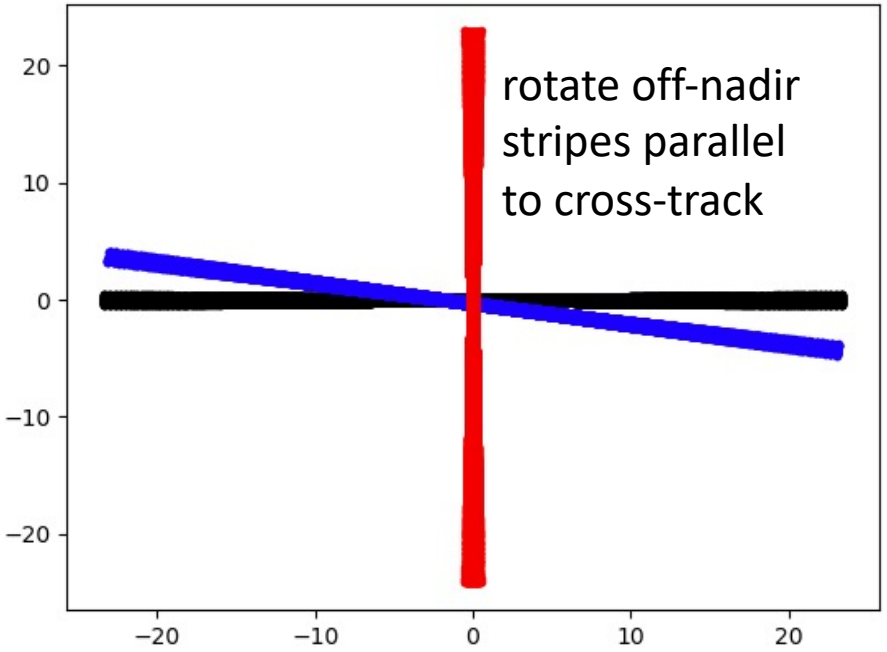


Validation/Calibration

Non Cross track

Pseudo-RAP maneuvers:
- Regression of non cross-track radiances for selected scene types
- Azimuthal flat-fielding over stable targets using VIIRS M4

Lunar maneuvers:
- Use limb observations to fill in flat-fielding at periphery of FOV
- Potential use of the limb/moon for radiometric calibration

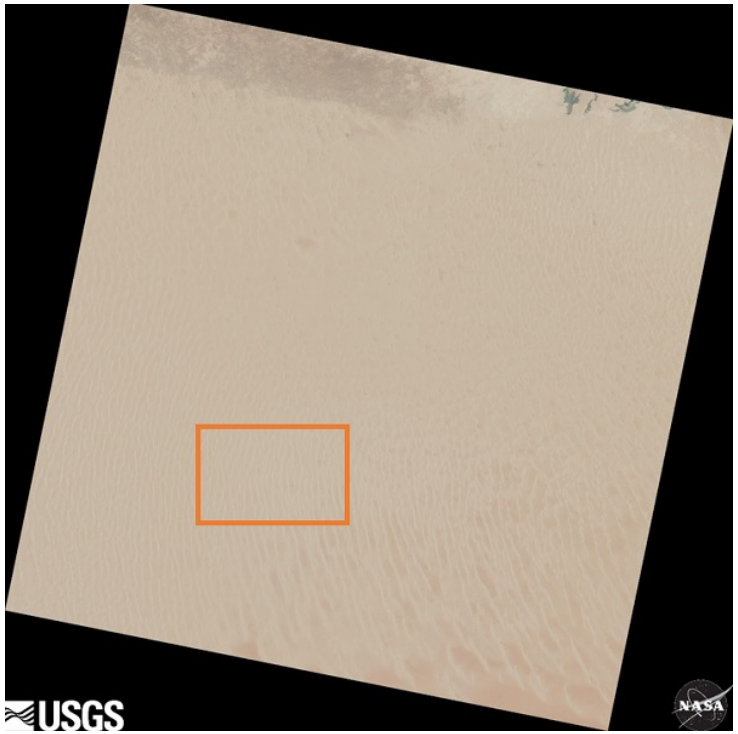


Performance Attributes*:
- Target radiometric accuracy 5%
- Target uniformity 1.5%

Ground Characterization
- At Ball/LASP

On-orbit
- No onboard calibrator in “demo mode”
- Rely on vicarious methods (for now)

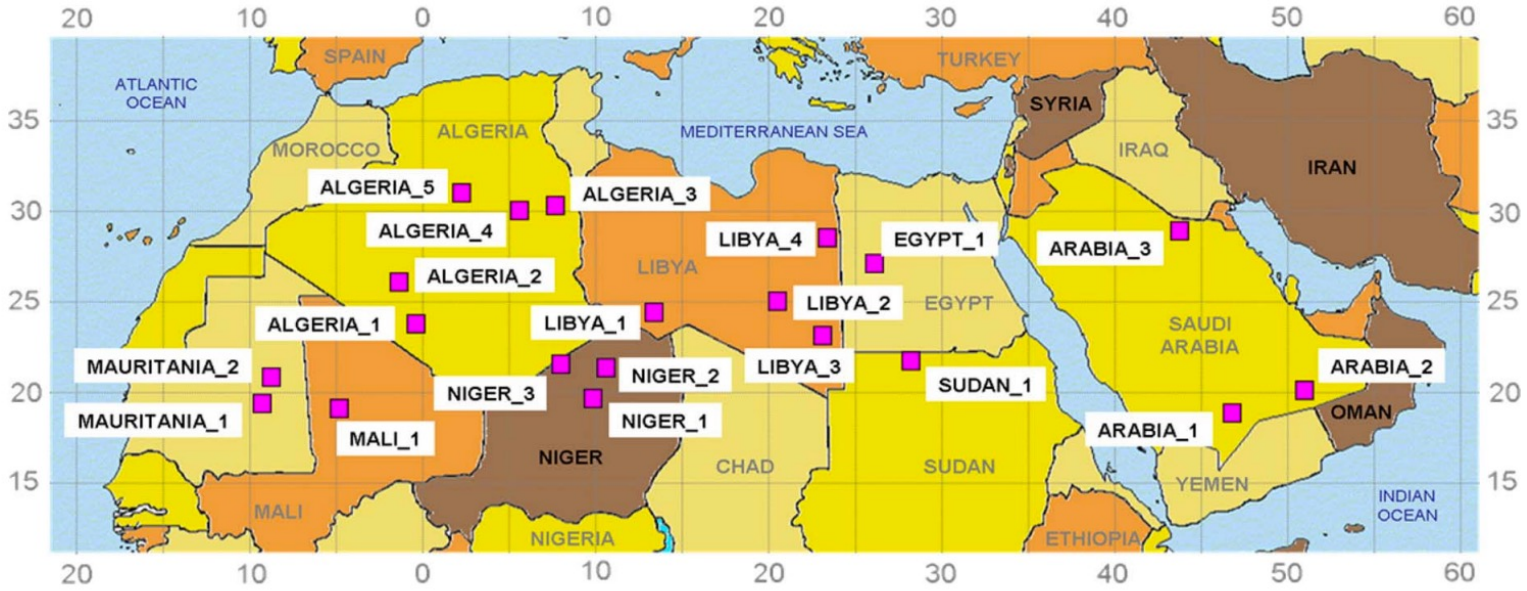
Currently flowing top-level requirements to component-level requirements + approach

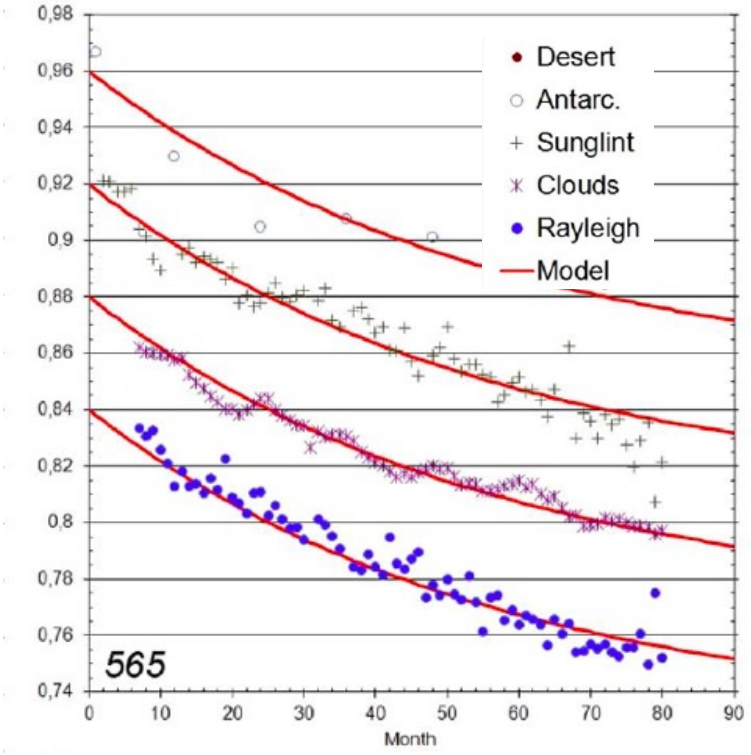


* also: filter spectral response; image distortion; detector linearity; dark current (T); straylight

Stability

Ensure stability over time via vicarious calibration methods:
Bacour et al, 2019

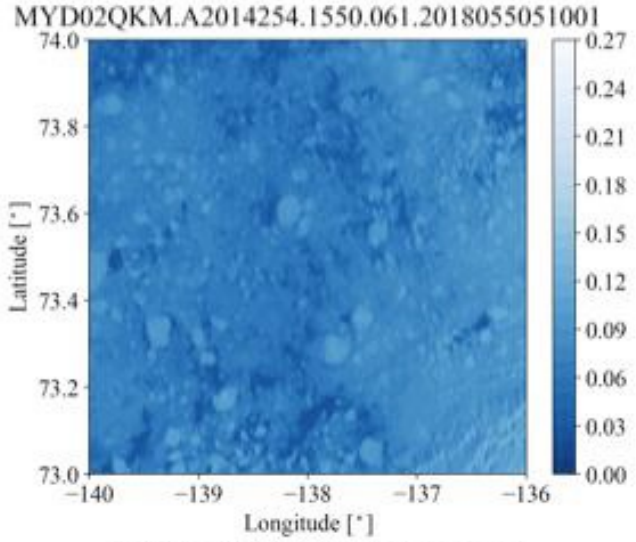




New Remote Sensing Avenues

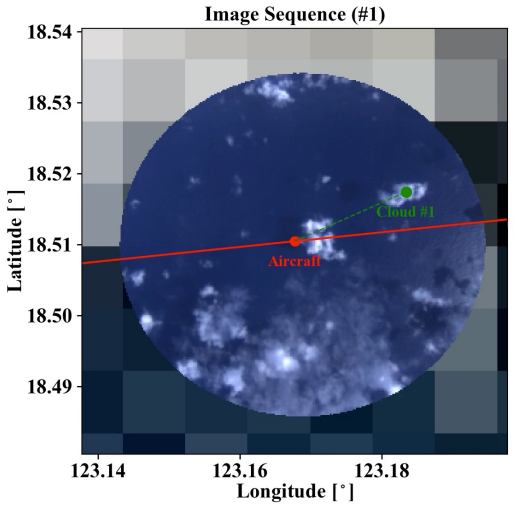
Over bright surfaces, the adaptive thresholding method for cloud detection based on single band will fail (will nominally rely on VIIRS), but…

…we are working on feature tracking algorithms which detect clouds based on stereoscopic methods
…may also be able to determine cloud top height



Multi-overpass imagery of clouds and ice floes during ARISE → ARCSIX

Multi-angle airborne camera imagery during ARISE 2014



#1: 980 m
#2: 1050 m
#3: 860 m

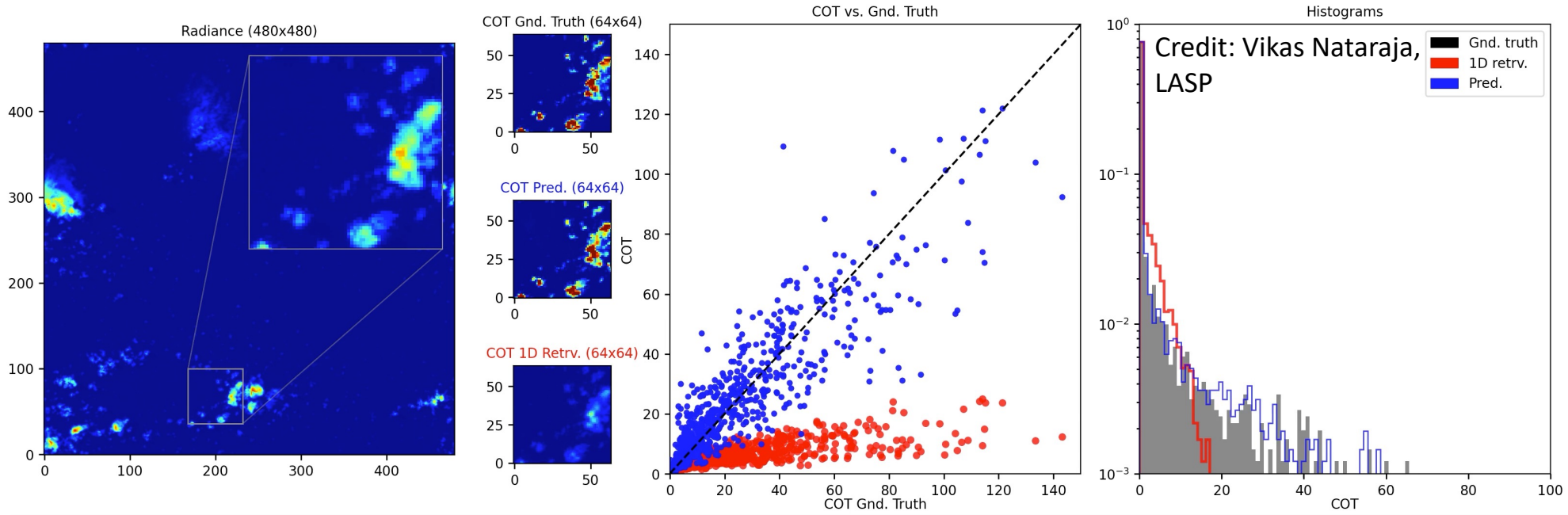
Multi-angle airborne camera imagery during CAMP²Ex 2019

New Remote Sensing Avenues

From one single channel, we are not expecting retrievals of cloud optical properties, but...

…we developed a Convolutional Neural Network retrieval for COD (so far, for water clouds, Nataraja et al., 2021), which detects/corrects for 3D effects

…various multi-angle/multi-pixel approaches* will be available for AtmOS → piggy-back



- Multi-angle algorithms (Shi et al., 2008); feature tracking (Kölling et al., 2019) → stereo height
- Multi-pixel algorithms (Jafariserajehlou et al., 2019) → thin cloud detection even over bright surfaces
- Convolutional neural networks (Nataraja et al., 2021) + cloud tomography (Levis et al., 2020)

Summary

Camera accelerates split-solar channel ADM aggregation (use 555 nm as proxy for Libera-VIS in off-cross-track direction)

New Remote Sensing Avenues that rely on limb-to-limb angular radiance measurements

Full definition of sampling and attributes still ongoing → feedback in the process and ideas are solicited